Claims

1. A handwheel-operated device comprising a body, a handwheel and a chuck, the handwheel and the chuck being rotatable relative to the body, and the device further comprising a first motor operable to rotate the chuck, first sensor means responsive to rotation of the handwheel and first control means operable in conjunction with the first sensor means to cause the first motor to rotate the chuck in dependence upon an angular displacement and/or angular velocity of the handwheel.

2. A device according to claim 1, wherein the first control means is operable to modulate a voltage applied to the first motor.

3. A device according to claim 2, wherein the first control means is operable to modulate the voltage applied to the first motor such that the magnitude of the voltage is substantially proportional to the angular velocity of the handwheel.

4. A device according to claim 2, wherein the first control means is operable to modulate the voltage applied to the first motor such that an angular displacement and/or angular velocity of the handwheel results in a corresponding angular displacement and/or angular velocity of the chuck.

5. A device according to claim 2, wherein the first control means is operable to modulate the voltage applied to the first motor in dependence upon the angular velocity of the handwheel such that the angular velocity of the chuck is non-linearly related to the angular velocity of the handwheel, the ratio of handwheel angular velocity to chuck angular velocity decreasing with increasing handwheel angular velocity.

6. A device according to any of claims 2 to 5, wherein the first control means is operable to cause the polarity of the voltage applied to the first motor to be dependent on the sense of rotation of the handwheel so that changing the direction of rotation of the

handwheel reverses the polarity of the voltage applied to the first motor, and hence reverses the direction of rotation of the chuck.

7. A device according to any preceding claim, wherein the first control means includes a proportional-plus-integral (PI) controller.

8. A device according to claim 7, wherein the first control means is operable to turn off the PI controller if the speeds of rotation of the handwheel and chuck fall below respective first threshold speeds.

9. A device according to claim 8, wherein the first control means is operable to turn on the PI controller if the speed of rotation of the handwheel rises above a second threshold speed.

10. A device according to claim 9, wherein the second threshold speed is greater than the first threshold speed.

11. A device according to any preceding claim, further comprising a variable low-pass signal filter operable to receive signals representative of the angular displacement and/or angular velocity of the handwheel from the first sensor means and to transmit signals below a cut-off frequency to the first control means and to attenuate signals above the cut-off frequency so as to prevent them from reaching the first control means, the cut-off frequency being determined by the angular velocity of the handwheel.

12. A device according to claim 11, wherein the variable low-pass signal filter is operable to decrease the cut-off frequency with increases of angular velocity of the handwheel up to a threshold angular velocity, above which increases of angular velocity of the handwheel do not affect the cut-off frequency.

13. A device according to any preceding claim, wherein the first sensor means comprises an angular displacement sensor.

14. A device according to claim 13, wherein the angular displacement sensor is a claw pole motor, an arrangement of a slotted disc rotatable relative to one or more optical sensors, or an arrangement of a multipole magnet rotatable relative to one or more Hall effect sensors and/or coils.

15. A device according to claim 13 or 14, wherein a first gear wheel is attached to a shaft of the angular displacement sensor, a second gear wheel is attached to the handwheel, and the first and second gear wheels are engageable with one another either directly or via one or more intermediate gears, so that each revolution of the second gear wheel causes the first gear wheel to rotate through more than 360°.

16. A device according to any preceding claim, wherein the first sensor means comprises a second motor, a shaft of which is coupled for rotation to the handwheel, and measurement means for measuring one or more parameters related to a speed and direction of rotation of the shaft of the second motor, and computation means operable to derive a speed and direction of rotation of the shaft of the second motor, and hence a speed and direction of rotation of the handwheel, from the one or more measured parameters.

17. A device according to claim 16, wherein the measurement means is operable to measure a back electromotive force (emf) generated by the second motor.

18. A device according to claim 16 or 17 when dependent from claim 15, wherein the shaft of the angular displacement sensor is coupled for rotation to the rotor of the second motor, and the first gear wheel is attached to the shaft of the second motor.

19. A device according to any preceding claim, further comprising second sensor means operable to determine a torque developed by the first motor, torque feedback means coupled to the handwheel and second control means operable in conjunction with the second sensor means to cause the torque feedback means to oppose the rotation of the handwheel.

20. A device according to claim 19, wherein the second sensor means comprises a force sensor and the first motor is mounted in the body of the device such that, in use, a torque developed by the first motor causes a torsional reaction force to be exerted on the force sensor.

21. A device according to claim 20, wherein the force sensor is a piezoelectric crystal.

22. A device according to claim 19, wherein the second sensor means comprises measurement means for measuring one or more parameters related to the torque of the first motor, and computation means operable to derive a torque of the first motor from the one or more measured parameters.

23. A device according to claim 22, wherein the measurement means is operable to measure a current supplied to the first motor.

24. A device according to any of claims 19 to 23, wherein the torque feedback means comprises a variable brake engageable with the handwheel under the control of the second control means.

25. A device according to any of claims 19 to 23 when dependent from any of claims 16 to 18, wherein the torque feedback means comprises a second control means that is operable to supply current to the second motor so as to oppose the rotation of the handwheel.

26. A device according to any preceding claim, further comprising a battery to allow the device to be operated cordlessly, and third sensor means operable to determine an electromotive force (emf) developed by the battery, the first control means being operable in conjunction with the third sensor means to modulate the voltage applied to the first motor so that, at least until the battery is substantially discharged, decreases in the emf developed by the battery do not cause decreases of the speed of rotation of the chuck.

27. A device according to any preceding claim, further comprising fourth sensor means operable to determine a magnitude of a current supplied to the first motor, the first control means being operable in conjunction with the fourth sensor means to limit the magnitude of the current supplied to the first motor if the magnitude of the current exceeds a threshold level.

28. A device according to any preceding claim, further comprising biasing means and mechanical braking means, the biasing means being operable to urge the mechanical braking means into engagement with the handwheel so as to oppose the rotation of the handwheel.

29. A device according to claim 28, wherein the mechanical braking means is a felt-covered pad.

30. A device according to any preceding claim, wherein the handwheel is provided with a handle movable between a folded position and an extended position.

31. A device according to claim 30, wherein the handwheel further comprises latch means operable releasably to retain the handle in the extended position.

32. A device according to claim 30 or 31, wherein the body of the device and the handle of the handwheel are formed such that in the folded position the handle engages with the body so as to prevent rotation of the handle relative to the body.

33. A device according to any of claims 30 to 32, further comprising first switch means engageable with the handle, such that the first control means is operable to cause the first motor to rotate the chuck only when the handle is in the extended position.

34. A device according to any of claims 30 to 33, further comprising a first further manual control movable between an "off" position and an "on" position, wherein

movement of the first further manual control to the "on" position when the handle is in its folded position causes the first motor to rotate the chuck.

35. A device according to claim 34 when dependent from claim 33, wherein the first control means is operable to cause the first motor to rotate the chuck only when the handle is in the extended position and the first further manual control is moved to the "on" position.

36. A device according to claim 34 or 35, further comprising a second further manual control movable between "clockwise", "anti-clockwise" and "off" positions, wherein with the second further manual control in the "clockwise" or "anti-clockwise" positions, movement of the first further manual control to the "on" position when the handle is in its folded position causes the first motor to rotate the chuck clockwise or anti-clockwise, respectively.

37. A device according to claim 36, wherein the first control means is operable to cause the first motor to rotate the chuck only when the handle is in the extended position, the first further manual control is moved to the "on" position and the second further manual control means is moved to the "off" position.

38. A device according to any preceding claim, wherein the body of the device comprises a first portion to which the handwheel is attached and a second portion attached to, and movable between a first and a second position relative to, the first portion.

39. A device according to claim 38, further comprising switch means operable by the first or second portion such that the switch means is closed when the second portion is in the first position and open when the second portion is in the second position and the first control means is operable when the switch means is closed to cause the chuck to rotate in one sense when the handwheel is rotated in a first sense, and operable when the switch means is open to cause the chuck to rotate in the opposite sense when the handwheel is rotated in the first sense.

40. A device according to any preceding claim, wherein the device is a power tool.

41. A device according to any preceding claim, wherein the device is a cordless electric drill.

42. A device according to any of claims 1 to 40, wherein the device is an electric food blender.

43. A method of controlling a motor of a handwheel-operated device, the device having a body, a handwheel, a chuck and a motor, the handwheel being rotatable relative to the body and the motor being operable to rotate the chuck relative to the body, the method comprising sensing rotation of the handwheel and causing the motor to rotate the chuck in dependence upon the angular displacement and/or angular velocity of the handwheel.

44. A handwheel-operated device as hereinbefore described with reference to, and as illustrated in, Figures 1 to 3, 11 to 13 and 16 to 23 of the accompanying drawings.

45. A method of controlling a motor of a handwheel-operated device, the method as hereinbefore described with reference to, and as illustrated in, Figures 4 to 10, 14 and 15 of the accompanying drawings.